CLAIMS

1.   A method of determining the existence of an instability within a process control loop comprising the steps of:

measuring one or more signals within the process control loop when the process control loop is connected on-line within a process control environment;

storing the one or more measured signals as signal data; and

performing an analysis on the stored signal data to determine the existence of an instability within the process control loop.

2.   The method of claim 1, wherein the step of measuring includes the step of measuring two signals and the step of performing an analysis includes the steps detecting the number of reversals in each of the two signals over a particular period of time and determining the difference in the number of reversals in the two signals over the particular period of time.

3.   The method of claim 1, wherein the step of performing an analysis includes the step of performing a Fourier transform on the one or more signals and detecting changes in the spectrum of the one or more signals to determine the existence of an instability.

4.   The method of claim 1, wherein the step of performing an analysis includes the step of using the Wiener-Khinchine relation to determine the existence of an instability.

5.   The method of claim 4, wherein the step of using the Wiener-Khinchine relation includes the step of identifying changes in the spectrum of the one or more signals by calculating changes in the variance of the one or more signals.

6.   The method of claim 1, wherein the step of measuring includes the step of measuring two signals and wherein the step of performing an analysis includes the step of determining the variance of the two signals, calculating the ratio of the variances of the two signals and comparing the ratio to a preset value to determine the existence of an instability.

7.   The method of claim 6, wherein the step of measuring includes the steps of measuring a command signal and a travel signal.

8.   The method of claim 6, wherein the step of calculating includes the step of calculating the ratio of the variances of the two signals recursively.

9.   The method of claim 8, wherein the step of calculating the ratio of the variance of the two signals recursively includes the step of using forgetting factors.

10.   A method of determining the source of an instability within a process control loop comprising the steps of:

measuring one or more signals within the process control loop when the process control loop is connected on-line within a process control environment;

storing the one or more measured signals as signal data; and

performing an analysis on the stored signal data to determine the source of the instability within the process control loop.

11.   The method of claim 10, wherein the step of measuring includes the steps of measuring a first signal and a second signal within the process control loop when the process control loop is connected on-line within the process control environment and wherein the step of performing an analysis includes the steps of identifying a lead/lag relationship between the first and the second signals and determining the source of the instability based on the determined lead/lag relationship.

12. The method of claim 11, wherein the step of measuring measures a pressure signal as the first signal and a travel signal as the second signal and wherein the step of determining includes the step of identifying the source of the instability as friction when the pressure signal leads the travel signal.

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13. The method of claim 11, wherein the step of measuring measures a pressure signal as the first signal and a travel signal as the second signal and wherein the step of determining includes the step of identifying the source of the instability as an external force when the pressure signal lags the travel signal.

14. The method of claim 11, wherein the step of measuring measures a

10 pressure signal as the first signal and a travel signal as the second signal and wherein the step of determining includes the step of identifying the source of the instability as an external force when the pressure signal is negatively correlated to the travel signal.

15. The method of claim 10, wherein the step of measuring includes the steps of measuring a first signal and a second signal within the process control loop

15 when the process control loop is connected on-line within the process control environment and wherein the step of performing an analysis includes the steps of determining a positive or a negative correlation between the first and the second signals and determining the source of the instability based on the determined correlation.

20 16. The method of claim 15, wherein the step of measuring measures a pressure signal as the first signal and a travel signal as the second signal and wherein the step of determining includes the step of identifying the source of the instability as friction when the pressure signal is positively correlated to the travel signal.

17.   The method of claim 10, wherein the step of performing an analysis includes the steps of determining a phase lag introduced by each of a number of elements within a process control loop and identifying the element that introduces the most phase lag in the process control loop.

5   18.   The method of claim 10, wherein the step of performing an analysis includes the steps of determining a phase lag introduced by each of a number of elements within a process control loop and ordering the elements according to the amount of phase lag each element introduces into the process control loop.

        19.   The method of claim 10, wherein the step of performing an analysis
10   includes the steps of determining a phase lag introduced by each of a number of elements within a process control loop and providing a cumulative phase lag chart indicting the detected phase lags.

        20.   The method of claim 10, wherein the step of measuring includes the step of measuring two or more signals and the step of performing an analysis includes
15   the steps of adding the phases of the two or more signals together to produce a summed phase signal and comparing the summed phase signal to a threshold.

        21.   The method of claim 20, wherein the step of performing an analysis includes the step of determining that the source of the instability is between the two signals when the summed phase signal is approximately equal to -180 degrees.

22.   The method of claim 10, wherein the step of measuring includes the step of measuring two signals and the step of performing an analysis includes the steps detecting the number of reversals in each of the two signals over a particular period of time and determining the difference in the number of reversals in the two signals over the particular period of time.

23.   A system for determining a source of an instability within a process control loop when the process control loop is connected on-line within a process environment, the system comprising:

a sensor that measures a first signal within the process control loop when the process control loop is connected on-line within the process environment;

a memory that stores the measured first signal as signal data; and

a processor adapted to perform an analysis on the stored signal data to determine the source of the instability.

24.   The system of claim 23, further including a second sensor that measures a second signal within a process control loop when the process control loop is connected on-line within the process environment and wherein the memory stores the measured second signal as secondary signal data and the processor is adapted to perform the analysis on the stored signal data and the stored secondary signal data to determine the source of the instability.

25.   The system of claim 24, wherein the first sensor is a pressure sensor that produces a pressure signal as the first signal and the second sensor is a travel sensor that produces a travel signal as the second signal and wherein the processor is adapted to identify the source of the instability as friction when the pressure signal leads the travel signal.

26.   The system of claim 24, wherein the first sensor is a pressure sensor that produces a pressure signal as the first signal and the second sensor is a travel

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sensor that produces a travel signal as the second signal and wherein the processor is adapted to identify the source of the instability as an external force when the pressure signal lags the travel signal.

27. The system of claim 24, wherein the processor is adapted to identify a lead/lag relationship between the first signal and the second signal and to determine the source of the instability based on the determined lead/lag relationship.

28. The system of claim 24, wherein the processor is adapted to use at least the first and second signals to determine a phase lag introduced by each of a number of elements into a process control loop and to identify the element that introduces the most phase lag into the process control loop.

29. The system of claim 24, wherein the processor is adapted to use at least the first and second signals to determine a phase lag introduced by each of a number of elements within a process control loop and to order the elements according to the amount of phase lag each element introduces into the process control loop.

30. The system of claim 24, wherein the processor is adapted to use at least the first and second signals to determine a phase lag introduced by each of a number of elements within a process control loop and to provide a cumulative phase lag chart indicting the detected phase lags.

31. The system of claim 24, wherein the processor is adapted to identify a positive or a negative correlation between the first signal and the second signal and to determine the source of the instability based on the determined correlation.

32. The system of claim 31, wherein the first sensor is a pressure sensor that produces a pressure signal as the first signal and the second sensor is a travel

sensor that produces a travel signal as the second signal and wherein the processor is adapted to identify the source of the instability as friction when the pressure signal is positively correlated to the travel signal.

33.   The system of claim 31, wherein the first sensor is a pressure sensor that produces a pressure signal as the first signal and the second sensor is a travel sensor that produces a travel signal as the second signal and wherein the processor is adapted to identify the source of the instability as an external force when the pressure signal is negatively correlated to the travel signal.

34.   The system of claim 24, wherein the processor is adapted to sum the phases of the first and second signals together to produce a summed phase signal and to compare the summed phase signal to a threshold to identify the source of the instability.

35.   The system of claim 34, wherein the processor is adapted to determine that the source of the instability is in a component between the first and second signals when the summed phase signal is approximately equal to -180 degrees.

36.   The system of claim 24, wherein the processor is adapted to detect the number of reversals in each of the two signals over a particular period of time and to determine the difference in the number of reversals in the two signals over the particular period of time.

37.   A system to be used in a process control environment to determine an existence of or a source of an instability within a process control loop, the system comprising:

a computer readable memory;

5   a first routine stored on the computer readable memory and adapted to be executed on a processor to collect and store data indicative of one or more signals associated with the process control loop while operating on-line within the process control environment; and

a second routine stored on the computer readable memory and adapted to be
10   executed on a processor to perform a statistical analysis on the stored data to determine the existence of or the source of the instability within the process control loop.

38.   The system of claim 37, wherein the second routine is adapted to use the data indicative of the one or more signals to determine a phase lag introduced by
15   each of a number of elements into a process control loop and to identify the element that introduces the most phase lag into the process control loop.

39.   The system of claim 37, wherein the second routine is adapted to use the data indicative of the one or more signals to determine a phase lag introduced by each of a number of elements within a process control loop and to order the elements
20   according to the amount of phase lag each element introduces into the process control loop.

40.   The system of claim 37, wherein the second routine is adapted to use the data indicative of the one or more signals to determine a phase lag introduced by each of a number of elements within a process control loop and to provide a
25   cumulative phase lag chart indicting the detected phase lags.

41.   The system of claim 37, wherein the first routine is adapted to collect and store data indicative of first and second signals and wherein the second routine is adapted to identify a lead/lag relationship between the first and the second signals and to determine the source of the instability based on the determined lead/lag relationship.

42.   The system of claim 41, wherein the first signal is a pressure signal and the second signal is a travel signal and wherein the second routine is adapted to identify the source of the instability as friction when the pressure signal leads the travel signal.

43.   The system of claim 41, wherein the first signal is a pressure signal and the second signal is a travel signal and wherein the second routine is adapted to identify the source of the instability as an external force when the pressure signal lags the travel signal.

44.   The system of claim 37, wherein the first routine is adapted to collect and store data indicative of first and second signals and wherein the second routine is adapted to identify a positive or a negative correlation between the first and the second signals and to determine the source of the instability based on the determined correlation.

45.   The system of claim 44, wherein the first signal is a pressure signal and the second signal is a travel signal and wherein the second routine is adapted to identify the source of the instability as friction when the pressure signal is positively correlated to the travel signal.

46.   The system of claim 44, wherein the first signal is a pressure signal and the second signal is a travel signal and wherein the second routine is adapted to identify the source of the instability as an external force when the pressure signal is

negatively correlated to the travel signal.

47.   The system of claim 37, wherein the first routine is adapted to collect
and store data indicative of first and second signals and wherein the second routine is
adapted to sum the phases of the first and second signals together to produce a
summed phase signal and to compare the summed phase signal to a threshold to
identify the source of the instability.

48.   The system of claim 47, wherein the second routine is adapted to
determine that the source of the instability is in a component between the first and
second signals when the summed phase signal is approximately equal to -180 degrees.

49.   The system of claim 37, wherein the first routine is adapted to collect
and store data pertaining to two signals and wherein the second routine is adapted to
detect the number of reversals in each of the two signals over a particular period of
time and to determine the difference in the number of reversals in the two signals over
the particular period of time.

50.   The system of claim 37, wherein the second routine is adapted to
perform a Fourier transform on the one or more signals and to detect changes in the
spectrum of the one or more signals to identify the existence of an instability.

51.   The system of claim 37, wherein the second routine is adapted to use
the Wiener-Khinchine relation to determine the existence of an instability.

52.   The system of claim 51, wherein the second routine identifies changes
in the spectrum of the one or more signals by calculating changes in the variance of
the one or more signals.

53.   The system of claim 37, wherein the first routine is adapted to collect and store data pertaining to two signals and wherein the second routine is adapted to determine the variance of the two signals, calculate the ratio of the variances of the two signals and compare the ratio to a preset value to determine the existence of an instability.

54.   The system of claim 53, wherein the second routine is adapted to calculate the ratio of the variances of the two signals recursively.

55.   The system of claim 53, wherein the second routine is adapted to calculate the ratio of the variances recursively using forgetting factors.